Lightning Launch Commit Criteria (LLCC)

Lightning triggered by a vehicle's flight is poorly understood and dangerous. Apollo 12 was struck twice by triggered lightning during its 1969 launch. Only robust backup systems saved the mission from disaster. In 1987, triggered lightning destroyed Atlas Centaur 67 during ascent. These accidents emphasized how little was understood about observing and forecasting the conditions which create triggered lightning, and resulted in 11 complex and restrictive lightning launch commit criteria (LLCC). To improve the LLCC to ensure mission success but not unnecessarily delay or scrub missions, NASA initiated a series of triggered lightning research programs. This research has driven a series of LLCC revisions which Department of Defense (DoD), Federal Aviation Administration (FAA), and most American private companies have adopted. To guide the research and recommend LLCC revisions, NASA and the Air Force formed the Lightning Advisory Panel (LAP) consisting of America's best atmospheric electricity experts.

A major LLCC revision was implemented during 2005 based on research conducted during 2000 and 2001. An aircraft was instrumented to directly measure electric fields aloft and cloud particle sizes, density, composition, etc. associated with the fields. Other sensors included the CCAFS/KSC network of 31 ground based field mills and two lightning detection systems, the Patrick AFB 5cm radar, and the Melbourne National Weather Service 10cm Doppler radar.

The data were rigorously quality controlled, calibrated, aligned, and synchronized. The master database was located on the National Center for Atmospheric Research website which allowed all participating scientists access and the ability to jointly discuss and collaborate on the subsequent analyses Proposed LLCC changes were developed during numerous telecoms from 2001 to 2005. The database is now archived on a KSC website.

Based on early analyses, the LAP recommended the LLCC's radar threshold for cloud edges, tops, sides and bottoms be changed from 10 dBZ to 0 dBZ. Launch programs implemented the change immediately to ensure flight safety. Later,

more detailed analyses of cloud-physics data showed 0 dBZ closely agreed with visible cloud edges.

The analysis team focused on the thunderstorm anvil LLCC. A reliable relation between radar and electric field data was achieved with a quantity called Volume Averaged Height Integrated Radar Reflectivity (VAHIRR). If specified VAHIRR thresholds are satisfied, the revised LLCC allow safe relief from the “do not fly through or within 5 nautical miles anvil rules. VAHIRR is a product of two quantities computed everywhere along the flight track: the average radar reflectivity (dBZ) of cloud in a volume horizontally centered on point of interest and the average cloud thickness above the freezing level within the specified volume. There are limitations--VAHIRR is not valid if any significant part of the volume is not scanned by the radar or is affected by attenuation or non-meteorological echoes. While ensuring flight safety, VAHIRR permits flight through or near anvils from distant thunderstorms. Initial rough estimates are that the changes will reduce the false alarm rate for anvils from ~ 90% to ~ 60%. The LLCC changes have been adopted by NASA, the Eastern and Western Ranges, the FAA, and Expendable Launch Vehicle (ELV) programs.